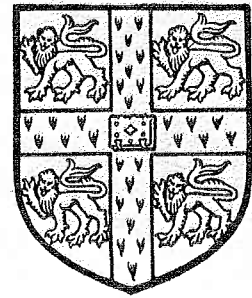


**CAMBRIDGE  
UNIVERSITY  
UNDERWATER  
EXPLORATION  
GROUP**



**MALTA EXPEDITION**

**1965**

## Members

F.M.Davis, Trinity Hall.

Aged 21. Expedition Organiser.  
Now studying Clinical Medicine at Westminster Hospital  
Medical School.

R.G.Crump, Trinity College.

Aged 22. Project Leader.  
Shortly commencing research at Portobello Marine Biological  
Station in New Zealand.

B.C.R.Bertram, St. John's College.

Aged 21. Zoologist.  
Now at the Sub-Department of Animal Behaviour, Madingley,  
Cambridge.

J.C.Gamble, St.Catharine's College.

Aged 21. Zoologist.  
Now on research grant at Menai Bridge Marine Science  
Laboratory, Anglesey.

G.J.S.Perry, Trinity Hall.

Aged 21. 4th Year Chemical Engineer.

R.A.Yorke, Clare College.

Aged 21. 3rd Year Engineer, reading Economics.

## Sponsors.

Dr.R.Bainbridge, Corpus Christi College, Cambridge.  
Zoology Department, Downing Street, Cambridge.

Dr.G.Salt, F.R.S., Kings College, Cambridge.  
Zoology Department, Downing Street, Cambridge.

Cambridge Malta Expedition 1965.

During the period July 6th till August 17th six undergraduate divers from Cambridge carried out a marine zoological project off the coast of Malta. It was hoped that we would find nocturnal behaviour in at least some of the native marine animals, and we were fortunate in finding, during the first two weeks, a number that did show just this phenomenon.

After a few night dives at Wied iz Zurrieq it became clear that a species of Holothurian present in large numbers during the hours of darkness was rarely if ever seen during the day. Also the Ophiuroids were more active at night, while a number of common fish present during the day were not seen at night.

Encouraged by this confirmation of our observations in Marseilles last year, we proceeded to analyse this phenomenon in greater detail. After examination of a number of possible working sites, we decided on Wied iz Zurrieq for all our work. In this way we hoped to benefit from an intimate knowledge of the area in which we were working, and thus avoid the danger of wasting time on exploratory diving.

We soon found that we could best use our small team by dividing the work into three sections, running the projects cocurrently, and distributing the divers as necessary each day. Accordingly the following report is divided into three sections dealing with Holothurians, Echinoids, and Fish in that order.

Observations made on the Diurnal Activity and some other Aspects of the Behaviour and Distribution of Regular Echinoids.

The sharp-spined regular echinoids *Paracentrotus lividus* Martensen and *Arbacia lixula* Loven are amongst the most abundant sublittoral invertebrates in Malta. Two other echinoid species, *Sphaerechinus granularis* Agassiz, and *Centrostephanus longispinus* Peters are occasionally to be found on the cliff and loose-rock substratum. Because of their abundance the work was conducted on *Paracentrotus* and *Arbacia*, with a brief look at *Sphaerechinus*. *Paracentrotus* and *Arbacia* could be differentiated between easily in the field after only very little practice.

Diurnal Activity.

Movement, as a criterion of activity, was followed over a 24 hour period in a series of labelled echinoids of both species.

Method: The movements of individual echinoids were measured relative to a set of fixed points on the substratum using a simple Triangulation method. The fixed points consisted of neoprene or cork floats attached by twine to the substratum. The spatial relationships of these to each other were determined, and the position of each echinoid measured relative to any three. The results were then scaled down (1/20) enabling a map of the movement to be plotted. From this the graphs of percentage movement were produced.

The problem of labelling echinoids underwater, disturbing them as little as possible, proved to be a difficult one. Barbed points (straight fish-hooks) with numbered plastic tags were used first. It was hoped originally to insert the point in the flexible periproctal membrane around the anus, but, owing to the small size of the urchins, the tendency was to insert it into the anus, with ejection of the point and rapid fatality. It was then found that the points could be tapped gently into the test. The initial reaction of the urchins to the point was rather vigorous, with considerably increased movement. In one *Arbacia* in particularly favourable circumstances, it was observed that the movement was directly away from the position and direction of insertion, and the range of movement was 25 cms in the first five minutes, compared with an estimated average daily movement in echinoids of these species of 2 M.

Experiment 1: Four days after labelling eight echinoids, one *Arbacia* and one *Paracentrotus* were followed over 24 hours, observations being made every three hours. The results obtained did not show any periodicity for these two individuals. Within a week to a fortnight from this 24 hour watch, however, all labelled echinoids were dead. The success of the

Oxford Expedition using stainless steel points, and the rusty appearance of the intra-echinoid part of our points lead us to suggest that the tin plating of ours tended to dissolve and poison the animal. Clearly, normal activity was being masked by the animals' response to this chronic noxious stimulus.

Another labelling method had to be devised. C.C. Hemmings suggested sliding small pieces of plastic sleeve insulation from electric wire over individual spines. This proved possible, and the initial reaction consisted of a brief local spine response, without, to the best of our knowledge, any increase in locomotor activity. The echinoid will shed the labelled spine within 36 - 48 hours. Thus to avoid losing track of our experimental animals a system of multiple tagging (two or three per animal) and a regular transfer of the labels to other spines every day was used.

Experiment 2: A 24 hour watch was carried out on an experimental group of six echinoids, four *Paracentrotus*, and two *Arbacia*. Because of the increased numbers, observations were made every four hours. The results were plotted as before. Five individuals followed a similar pattern, and the result for this group is represented in Fig. 1.

It can be seen that in three *Paracentrotus* and two *Arbacia* there is a marked increase in the distance travelled during the period of darkness compared with the daylight hours. On average approximately two thirds of the total movement occurred during the eight hours of darkness. If the distance travelled can be taken as a function of the activity of the animal it appears that there is a marked diurnal change in the activity of these five echinoids.

The one sea-urchin which did not show an increase in movement at darkness was a *paracentrotus*, especially selected because it rested threequarters buried in a close-fitting hole in the rock. Many observations have been made on the rock-burrowing activities of echinoids, and it was hoped that this individual would move from and return to its hole, i.e. that it would show some sort of homing activity. However, from the time it was labelled on the 3rd August until the last dive on the 15th August, observations at different times of the day and night, including the 24 hour watch, showed this individual to remain in its hole. No locomotory activity was ever seen to occur.

The direction of movement during any period is not predictable, and thus our measurements approach fairly closely, but do not exactly equal the true distance. As we are comparing percentage movement over different periods, these errors should largely cancel out.



Vertical Distribution of Paracentrotus and Arbacia.

Three metre-wide vertical transects were carried out from the base of the cliff (100 feet) to the surface to see whether there was any change in the species composition of the Paracentrotus/Arbacia population. A count was made of all echinoids within a half-metre band to either side of a line laid down the cliff face. The numbers were totalled every 10 feet of depth, and are presented in Fig. 2.

Transect C should be especially noted as this was taken up a vertical rock face from 100-0 feet. In transects A & B the numbers in the range 10-40 feet are grossly exaggerated because of an approximately 40° (to horizontal) shelf between these depths. The relationship between the peaks of the two populations, however, remains much the same, that of Arbacia being 10-20 feet above that of Paracentrotus.

As Arbacia is more frequent in the southern Mediterranean than in the north, one is tempted to think that this is a temperature-controlled distribution but it appears that the temperature difference between these two peaks of population is too small to be the decisive factor. It could be that algal distribution and/or light intensity are important.

Covering.

Many echinoids are seen to cover themselves with bits of weed or other extraneous material. It is claimed (Dubris 1913) that this is a protective measure against light. Observations made on this expedition, however, tend to disprove this theory.

1. Three rough counts at different depths (10, 30, & 80 feet) showed, firstly, that Paracentrotus tends to cover itself whilst Arbacia does not, and, secondly, that with increasing depth there is no significant change in the numbers of the population covered.

	Arbacia P-centrotus		Arbacia P-centrotus		Arbacia P-centrotus	
Covered	5	56	11	76	0	82
Uncovered	74	16	63	25	11	13
Depth	10 feet		30 feet		80 feet	

2. A daily check on the covering of the six 'sleeve-labelled' echinoids showed that both Arbacia, and one Paracentrotus never had any cover. For the other three the results are as follows :

Date of Observation	A	B	C
3/8/65	+	+++	-
4/8/65	++	+	+

Date of Observation.	A	B	C
5/8/65	-	-	-
6/8/65	++	+	-
8/8/65	+	+	+

+ Denotes degree of covering      - No covering

As there was little, if any, variation of light intensity between any of these daily observations (all at the same depth, at midday, the weather being sunny), this variation in cover is surprising if it is dependent on light intensity.

3. On one dive, when heavy seas had caused an increase in floating detritus, it was noticed that many more echinoids than usual were carrying extraneous material.

From the above observations it appears that covering with extraneous material is not necessarily a response to high light intensity. It could be due to a local reflex on the part of the tube feet initiated by contact with any suitable surface. Material is actively held onto by the tube feet, not simply stuck over the spines.

#### Conclusions.

Both *Arbacia lixula*, and *Paracentrotus lividus* appear to exhibit a diurnal locomotor rhythm, being more active at night than during the day.

The peak of the *Paracentrotus* population occurs 10-20 feet below that of the *Arbacia* population. This distribution is probably determined by factors other than temperature.

Covering is not an active shading response, but is probably due to the tendency of the tube feet to cling onto any suitable surface.

#### Reference.

Dubois R. 1913. "Note sur l'action de la lumiere sur les echinoderms". C.R. 9. Internation. Congr. Zool.

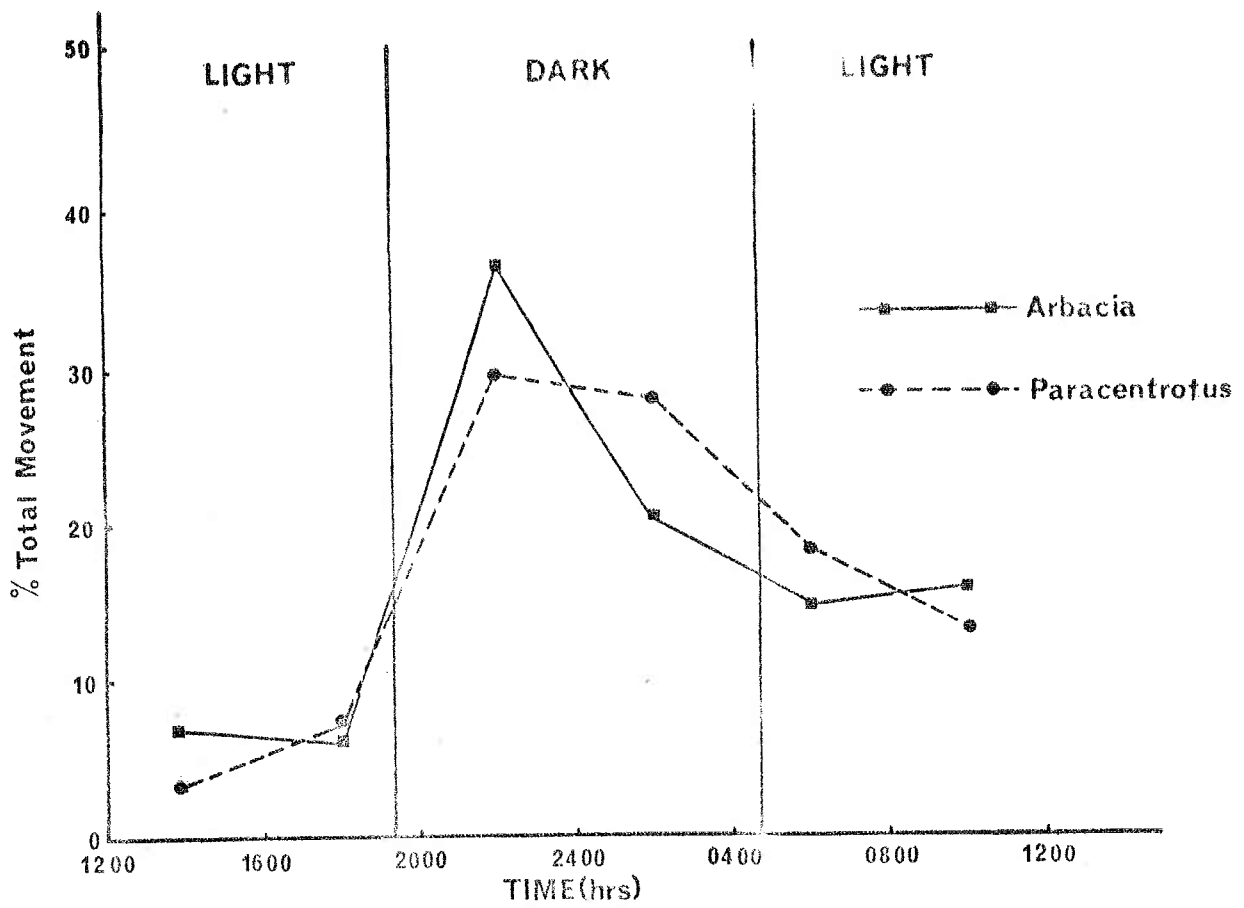


FIG. 1. % TOTAL MOVEMENTS DURING 24 Hr. WATCH 4-5th AUGUST 1965. AVERAGE FOR PARACENTROTUS AND ARBACIA.

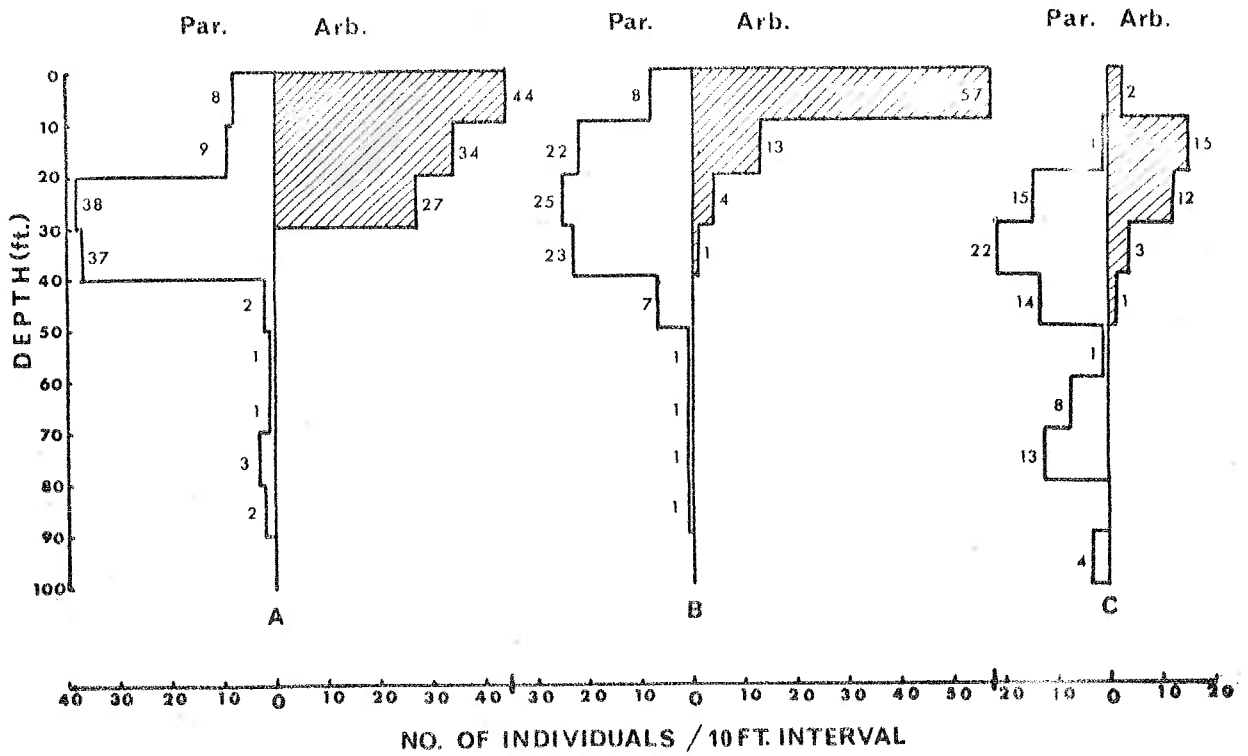


FIG. 2. COMPOSITION OF THE PARACENTROTUS (PAR.) / ARBACIA (ARB.) POPULATION AS SHOWN IN 3 METRE-WIDE LINE TRANSECTS FROM 0-100 Ft.



## Diurnal Activity in Holothuria.

On one of the first night dives we found a large rock on a sloping rock-debris bottom with a local population of about a dozen Holothurians, and we decided to concentrate our observations on an area four metres square around this rock. During the day there were no holothurians to be seen in the area, and from casual observations of the site made while doing a 24 hour watch on the Echinoids, it became apparent that these creatures are nocturnal. They seem to crawl out from holes in the substrate at dusk, browsing actively during the night, and going back into holes before dawn. To confirm this fact we watched the area from 1830-2000 hours, and were able to observe 14 animals emerge from holes amongst the rocks, and begin moving around in that time. This dusk observation was repeated several nights running with almost identical results.

Having confirmed the dusk emergence, the next obvious step was to attempt a continuous watch on the site during the hours of darkness which we did with the help of Hemmings, Lythgoe, et al. Thus we had ten divers and enough air to complete 12 one-hour dives if this proved necessary, although the period 1845 - 0500 hours proved sufficient for our purpose. The first diver went down at 1845, and plotted the positions of the animals, more or less as they appeared, on prepared formica boards every 15 minutes. He was relieved at 2000 hours by a second diver who continued to map the position of each animal at quarter-hour intervals. Continuity was achieved by the incoming diver receiving from his predecessor a formica board showing the last observation made. It was hoped in this way to get an idea of the movements of each individual, but in fact the identification proved most difficult and confusion about the identity of individual holothuria made continuous tracking impossible. Red torches were used for all observations as it had been found earlier that, while holothurians are very sensitive to white light, they are much less so to red.

Each individual was recorded on a formalised diagram of the site (Fig. 3) by a number and pattern designation, and the position estimated from metre tags along the peripheries and the central cross-line. Three types of Holothurians were distinguished for experimental purposes dependant on whether or not white or cream rings were present around the bases of the tubercles - Portholed, 'P', non-portholed, 'N', and an intermediate type in which only a small number of tubercles were ringed, 'p'. In general even this was not sufficient guide to the succeeding diver in identifying each animal, with certainty, especially when several were close together.

Despite the inability of divers to identify unmarked individuals it was possible to get a very clear idea of the numbers of individuals in the area at quarter hour intervals throughout the night. The results of this

